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COMBUSTION, BOILER, AND UTILITY GLOSSARY

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ABSOLUTE PRESSURE (abs press.)
Gauge pressure plus barometric pressure. Absolute pressure can be zero only in a perfect vacuum.

ABSOLUTE VISCOSITY (abs visc)
The product of a fluid's kinematic viscosity and its density. Absolute viscosity is a measure of a fluid's tendency to resist flow, with regard to its density. Sometimes called dynamic viscosity.

ADVANCED POWER CYCLE
Non-specific term used to describe possible means of producing power not yet reduced to wide practice. Includes MHD, and gasification coupled with high-pressure turbines.

AGGLOMERATING COAL: See caking coal.

AGGLUTINATING COAL: See coking coal.

AGGREGATIVE FLUIDIZED BED
A bed in such a condition of fluidization that the gas or fluid phase rises through the bed primarily in the form of bubbles.

AIR: See specific application --

Atomizing	Main
Combustion	Primary
Compressed	Secondary
Deficiency of	Standard
Excess	Theoretical
Low Pressure	

AIR/FUEL RATIO
The ratio of the air supply flow rate to the fuel supply flow rate when both are measured in the same units under the same conditions. Also used to indicate the ratio of air supplied to the stoichiometric amount.

AIR REGISTER
A type of burner mounting which may admit secondary air to the combustion space.

AIR SHUTTER
An adjustable shutter on a burner air register by means of which the amount of air induced into the furnace through the register can be controlled.

ALDEHYDE
A specific chemical compound (CH_3CHO); also a class of similar compounds.

ANL
Argonne National Laboratory.

ANTHRACITE
A hard, black lustrous coal containing a high percentage of fixed carbon and a low percentage of volatile material.

APCO: See OAP.

API
American Petroleum Institute.

API°
Scale adopted by the American Petroleum Institute to indicate the specific gravity of a liquid. The API scale is constructed in such a manner that gravity readings are higher for less dense liquids. Therefore the API gravity for a liquid rises as its temperature rises. Also referred to as degrees API.

ARTIFICIAL FUELS
Man-made fuels, including all manufactured and byproduct fuels. Examples are water gas, blast furnace gas, and coke.

ASH
Non-combustible mineral matter which remains after a fuel is burned.

ASH-FUSION TEMPERATURE(S)
Properly, three temperatures (initial-deformation, softening, and fluid) determined for a given coal ash per ASTM D-271. Frequently used in the singular to indicate only the softening temperature, the temperature at which the test cone has deformed to a sphere on the plaque. For operating conditions, the ash, at this temperature, shows a greatly accelerated tendency to mass together and stick, in large quantities, to boiler surfaces or to clinker. Also see fusion point.

ASPIRATOR MIXER
A gas/air proportioning device which uses the venturi principle to cause the flow of combustion air to induce the proper amount of gas into the air stream. It is used with low pressure air and gas at zero gauge pressure. Also called a suction type mixer.

ASTM (American Society for Testing & Materials)
An international nonprofit, technical, scientific, and educational society devoted to the promotion of knowledge of the materials of engineering, and the standardization of specifications and methods of testing.

ATMOSPHERE (atm)
Refers to a mixture of gases (usually that within a furnace). Also a unit of pressure equal to 14.696 lb per sq inch.

ATMOSPHERIC PRESSURE (atm press.)
The pressure exerted upon the earth's surface by the weight of the air and water vapor above it. Usually taken as 14.7 lb per sq inch.

ATMOSPHERIC (RATIO) REGULATOR
A diaphragm type regulator which maintains the gas pressure at atmospheric or "zero" pressure. Also called a zero governor.

ATOM
The smallest unit of an element which retains the properties of that element.

ATOMIZATION
The process of breaking a liquid into a multitude of tiny droplets.

ATOMIZATION: See specific application--
Centrifugal Mechanical Pressure
Compressed Air Oil Pressure
Low Pressure Air Steam

ATOMIZING AIR
That part of the air supplied through a burner (usually about 10 percent) which is used to break the oil stream into tiny droplets. The atomizing air is also used for combustion after it has broken up the oil stream.

ATTEMPERATOR
Apparatus for reducing and controlling the temperature of a superheated vapor or of a fluid passing through it.

AUTOMATIC CONTROL
An arrangement by which a system reacts to a change or an imbalance in one of its variables and compensates by adjusting the other variables to restore the system to the desired balance. For example, a system for control of air/fuel ratio can be set up in such a manner that a change in the setting of the combustion air valve results in a corresponding change in the fuel input.

AUXILIARY POWER
That power required to drive feed water pumps, fans, etc. of a steam plant. It is usually 4 to 8 percent of the gross generation at full load; at no load, it is approximately half that required at full load.

AVAILABLE CARBON
Carbon not combined chemically with oxygen in any way; hence, available for combustion.

AVAILABLE HEAT
The gross quantity of heat released within a combustion chamber minus both the dry flue gas loss and the moisture loss. It represents the quantity of heat remaining for useful purposes.

AVAILABLE HYDROGEN
Hydrogen not chemically combined with oxygen in any way; hence, available for combustion.

BAILEY METER
An instrument made by Bailey Meters which records air flow and steam flow relationship for a boiler. This aids in obtaining optimum air for the most efficient use of fuel.

BAROMETER
An instrument for measuring atmospheric pressure, usually in inches, centimeters, or millimeters of mercury column.

BAROMETRIC DAMPER
A balanced air valve placed to admit air to the flue pipe in order to maintain a constant amount of draft through a furnace. A minimum draft has the advantage of reducing the heat loss through the flue.

BAROMETRIC PRESSURE
The atmospheric pressure at a specific place according to the current reading of a barometer.

BARREL (bbl)
For petroleum, 42 gallons; otherwise, a drum or 55 gallons. Also, the cylindrical passage through which a fluid passes, as a culvert or duct.

BASE LOAD
Denotes high usage rate, generally in excess of 80 percent maximum capacity and nearly constant use. Used to identify those boilers and turbines which supply the base increment, or the minimum amount of power used. See also peaking and intermediate.

BATCH-TYPE FURNACE
A furnace shut down periodically to remove the old charge and add a new charge, as opposed to a continuous-type furnace.

BAUME°
A scale for expressing specific gravity of liquids, designed to provide a linear scale on hydrometers. Named for Antoine Baume (1727-1804), a French chemist widely known for his improvements in technical processes, but best known for his invention of the hydrometer which bears his name.

BBL/DAY
Barrels per day of petroleum, unless otherwise specified.

BCD
Barrels per calendar day.

BCR

Bituminous Coal Research. Also the prefix for the number assigned to a characterization of limestone or dolomite performed by this organization.

BCURA

British Coal Utilisation Research Association, a research and development unit of the British National Coal Board.

BED EXPANSION

The increase in the volume (or height) of the bed upon fluidization, compared to the settled bed.

BELLOWS

A metallic accordian-like box which can be compressed mechanically or with fluid pressure (like a spring), and which will return to its normal (extended) shape when the pressure is released. Bellows are used in oil expansion chambers, in some high-pressure safety shutoff valves in place of a diaphragm, and in pressure-sensitive instruments and regulators. May also be made of non-metallic material.

BENSON BOILER

A once-through type boiler.

BENSON CYCLE

A once-through type cycle.

BENT-TUBE BOILER

A boiler in which the water and steam tubes are bent to conform to the configuration and to enter the drums radially.

BITUMINOUS COAL

A coal which is high in carbonaceous matter, having between 15 and 50 percent volatile matter. Soft coal.

BLACK BODY

A theoretical physical concept of a body which would absorb all radiant energy incident upon it, and would emit the maximum possible radiation at a given temperature. The emissivity and the absorptivity of a black body are each 1.0. A black body would not necessarily be black in color. Lampblack and platinum black most nearly approximate a black body.

BLACK-BODY RADIATION

The theoretical rate of radiation from a black body at a given temperature.

BLAST FURNACE GAS

A gas of low Btu content recovered from a blast furnace as a byproduct and used as a fuel.

BLAST GATE
A shutoff air valve. It should not be used for flow control.

BLEEDER
An intentional leak, usually used to reduce pressure in an impulse line.

BLOWDOWN
A drawing or venting of part of the boiler water or steam to deconcentrate the impurities in the system. May be continuous or intermittent.

BLOWER IMPELLER: See closed impeller.

BLUE (WATER) GAS
An artifical fuel made by passing steam over incandescent carbon (usually coke). This forms a mixture of hydrogen and carbon monoxide ($C+H_2O \rightarrow H_2+CO$). The gas is poisonous because of its high CO content.

BOILER DERATE
A reduction in boiler capacity or rating; see Boiler Rating.

BOILER DUTY: See Duty.

BOILER EFFICIENCY
The ratio of the heat absorbed by water and steam in the boiler, superheater, and economizer, and by the air in the air heater to total heat input. It may also be described as heat input minus various losses, all expressed as percents. Heat input is taken at the higher heating value of the as-fired fuel. Ambient air is taken as 100°F at 40 percent relative humidity.

BOILER HORSEPOWER (HP)
An old variable rating for boilers. One nominal definition was: 1 HP equals 10 square feet of boiler heating surface. A "developed horsepower" was set as equal to the evaporation of 30 pounds of water per hour from an initial temperature of 100°F to steam at 70 lb per sq inch pressure. When the term "equivalent evaporation from and at 212°F" became popular, the old value of 30 lb at 100°F and 70 lb per sq inch for a developed boiler horsepower was converted to its equivalent in heat capacity of 34.5 lb of water per hour from and at 212°F. Still later, when steam flow began to be recognized as a better measure of size, an equivalent heat unit of 33,480 Btu per hour was used.

BOILER METER: See Bailey meter. Also made by others; e.g., Hagen and L&N.

BOILER RATING

A boiler's heat transfer capacity per unit time, compared to standard, expressed as a percentage. A rating of 200 to 300 is not unusual for modern units.

Since most modern boilers, whether small or large, have a relatively large heating surface area other than boiler convection surface, the terms "boiler rating" and "boiler horsepower" are not properly applied to these boilers. For discussion, see page 11-9 of "Steam, Its Generation and Use" (Babcock & Wilcox Company) and page 19-3 of "Combustion Engineering."

BOILING FLUIDIZED BED

A fluidized bed through which part of the fluidizing medium passes in the form of bubbles of a size approximately equal to the size of the solid particles, but very small relative to the dimensions of the containing vessel.

BOOSTER HEATER

A heater used to raise the temperature of oil from that required for pumping to that required for atomization. The booster heater is usually located close to the burner where atomization takes place.

BOTTLED GAS: See liquefied petroleum gas.

BOURDON TUBE

A metallic tube of elliptical cross-section, shaped into an arc or spiral with one end attached to an indicating, recording, or controlling device. It is used in industry to measure pressures. A pressure within the tube tends to make it less elliptical and more nearly circular, thus actuating the attached device.

BRADFORD BREAKER

A type of coal breaker using gravity force to reduce coal size, thus producing few fines.

BRANCH CIRCUIT

A secondary circuit leading from the main oil circulating loop to a burner or group of burners. Similar circuit for air, steam, etc.

BRAYTON CYCLE

A type of energy cycle, represented by a gas turbine. On a pressure volume diagram it is shown by isentropic compression, constant pressure heat addition, isentropic expansion, and constant pressure heat rejections. The work is the area enclosed by the above.

BREAKTHROUGH

Used to denote first appearance beyond or penetration of a bed, etc. Frequently used to denote first showing of SO_2 in the flue gas above the bed. Also that point where the SO_2 reaches a certain percentage of the calculated maximum SO_2 if no absorption were taking place.

BREECHING

A passageway leading from a furnace to its chimney.

BRING-UP TIME
The time required to raise a cold furnace, and its charge if any, to operating temperature.

BRITISH STANDARDS INSTITUTION: See BSI.

BRITISH THERMAL UNIT (Btu)
The quantity of heat required to raise 1 pound of water from 59°F to 60°F.

BSI
British Standards Institution. Responsible for the preparation of national standards for Great Britain. Comparable to the ASTM in the U.S.

BSI SWELLING TEST
Standardized test for the swelling, and to some extent the coking, properties of coals. See also Gray-King scale, and swelling number.

BTU: See British thermal unit.

BUBBLING FLUIDIZED BED
A bed in which the fluid bubbles are much larger than the suspended particles but small compared to the dimensions of the vessel.

BUCKSTAY
A beam attached to the tie bars with slip connections to prevent the furnace and boiler walls from bowing inward or outward.

BUNKER
Prepared coal storage container or area.

BUNSEN-TYPE BURNER
A gas burner consisting of a straight tube with a gas orifice at one end. Primary air enters through adjustable openings around the gas orifice and is entrained by the gas jet. The gas/air mixture burns with a short intense flame as it emerges from the tube. Bunsen-type burners which operate on low-pressure gas are sometimes called atmospheric burners. Named for R.W. Bunsen (1811-1899), to whom the invention of this burner is generally attributed. Bunsen is also noted for his research on furnaces: he proved that furnaces then used in his native Germany wasted 50 percent of the fuel heating value through the exhaust gases. His work in England revealed that their furnaces were losing 80 percent. He was the first to devise methods for measuring this heat loss, which led to many improvements.

BURN: See calcine.

BURNER
A device which positions a flame in the desired location by delivering fuel (and sometimes air) to the location. Some burners also atomize the fuel; some mix the fuel and air. See also specific application--

BURNER (see also)

Bunsen-type
Centrifugal atomizing oil
Combination
Compressed air atomizing oil
Dual-fuel
Flame retention
Large port
Long flame
Mechanical pressure atomizing
Nozzle mixing
Oil pressure atomizing
Ported manifold
Premix
Rotary cup oil
Simultaneous gas-oil
Small port
Steam atomizing
Vaporizing.

BURNER BLOCK: See burner refractory.

BURNER REFRACTORY
A refractory block with a conical or cylindrical hole through its center. The block is mounted in such a manner that the flame fires through this hole. The block helps to maintain ignition, and reduces the probability of flash-back or blow-off. Also called a burner block, burner tile, combustion tile, combustion block, refractory tile, or refractory block.

BURNER TILE: See burner refractory.

BUTANE
A gaseous hydrocarbon fuel (C_4H_{10}).

BUTANE, COMMERCIAL
The mixture of easily liquefiable hydrocarbon gases (consisting principally of butane) which is sold as "butane." It is one of the components of raw natural gas, but is also derived from petroleum refining processes.

BUTTERFLY VALVE
A damper or throttle valve in a pipe, consisting of a disk which rotates about its diameter as an axis.

BUTTON
Slang for air distribution port, cap, or nozzle on the grid of a fluidized bed.

BYPRODUCT COKE OVEN GAS
Gas given off during the process of making coke from coal. It consists chiefly of hydrogen and methane.

CAFB
Chemically active fluid bed. A fluidized bed of calcined limestone. Named by Esso Research Centre (U.K.).

CAKING COAL
Coal which, when heated, gives off volatile matter and then cakes (or cokes) into a continuous cake. All coking coals are caking coals but not all caking coals are coking coals.

CAL (cal): See calorie.

CALCINE
To expel volatile matter by heat, as carbon dioxide, water, or sulfur with or without oxidation. To roast. To burn.

CALCITE LIMESTONE
A limestone containing not more than 5 percent magnesium carbonate as defined by ASTM C119-50 test.

CALCITIC DOLOMITE
A carbonate rock composed of between 10 and 50 percent calcite and between 50 and 90 percent dolomite.

CALORIE
A gram calorie is the quantity of heat required to raise 1 gram of water from 4°C to 5°C. A kilogram calorie is one thousand times as large. A gram calorie is abbreviated cal; a kilogram calorie is is abbreviated Cal.

CALORIFIC VALUE
The heat, measured in calories or Btu, released by combustion of a unit quantity of a fuel.

CARBON BURNUP CELL: See CBC.

CARBON DIOXIDE, ULTIMATE PERCENT
The percentage of carbon dioxide which appears in the dry flue gases when a fuel is burned with its chemically correct air/fuel ratio. It is the theoretical maximum concentration of CO_2 which it is possible to obtain.

CARBONIZATION
The process of decomposing a non-volatile carbonaceous substance, usually coal, into solid, liquid, and gaseous products, by heating in a reducing atmosphere. Also, the process between the death of a plant or animal and the reduction to residual carbon, in situ, or the slow decay under water of organic material resulting in a film of carbon in the general form and structure of the tissue.

CARBON RESIDUE
The free carbon which remains when an oil is evaporated.

CARBURETED BLUE (WATER) GAS
Water gas with gaseous hydrocarbons added, originally for the purpose of increasing the flame's luminosity, but now added to increase the Btu content of the water gas.

CARNOT CYCLE
A type of energy cycle regarded as ideal. Other cycles may approach or equal its efficiency, but between specified temperatures, the efficiency of the Carnot cycle cannot be exceeded. On a pressure/volume diagram it is shown by isentropic compression, isothermal expansion, isentropic expansion, and isothermal compression. The work is the area enclosed by the above.

CARRYOVER: See entrainment.

CBC

Carbon burnup cell. A small fluidized-bed unit operating at a higher temperature and different air ratios than the main unit. Used to completely combust carbon entrained from the main fluidized bed. Also, that section of the furnace where entrained carbon is burned upon recycling.

CEGB

Central Electricity Generating Board (British). Loosely, Britain's nationalized electric generating industry. Also those directors who make up the governing body of the electricity generating industry.

CENTIPOISE

A unit for measurement of absolute viscosity. One centipoise is equal to one hundredth of a poise, the metric (cgs) unit of absolute viscosity. The absolute viscosity of water at 20°C is approximately 1 centipoise. See poise.

CENTISTOKE

A unit for measurement of kinematic viscosity. One centistoke is equal to one hundredth of a stoke, the metric (cgs) unit of kinematic viscosity. The kinematic viscosity in centistokes times the density equals the absolute viscosity in centipoises. See stoke.

CENTRAL ELECTRICITY GENERATING BOARD: See CEGB.

CENTRAL STATION

An electrical power generating station serving many consumers.

CENTRIFUGAL ATOMIZING OIL BURNER

A burner in which oil is thrown by centrifugal force from a rotating cup into an air stream, causing the oil to break into a spray.

¢/BBL

Cents per barrel, usually petroleum.

¢/BBL-MILE

Cents per barrel per mile, usually petroleum.

¢/100 LB

Cents per hundred pounds.

¢/100 LB-MILE

Cents per hundred pounds per mile.

CHAIN GRATE

A type of stoker which has assembled links, grates, or keys joined together in an endless belt arrangement that passes over sprockets or return bends located at the front and rear of the furnace. Coal is fed onto the moving assembly from an overhead hopper and conveyed through the furnace. At the return bend, the keys break with a scissor action.

CHANNELING FLUIDIZED BED

An abnormality characterized by the establishment of flow paths through which disproportionately large amounts of fluid (gas) will pass up the column.

CHEMICALLY ACTIVE FLUID BED: See CAFB.

CHIMNEY ACTION: See stack effect and stack draft.

CINDER RETURN

The returning, to the combustion zone, of the ash and/or carbon removed from the gases leaving the furnace. Also called fly ash recycle.

CIRCULAR MIL

A unit used in measuring the cross-sectional area of wires. It is equal to the area of a wire having a diameter of 1 mil, or 0.001 inch.

CIRCULATING LOOP

The main loop in which oil is circulated from the oil storage tanks to the branch circuits and then back to the storage tank. Also similar loop for other materials.

CITY GAS

Gaseous fuel supplied via a piped distribution system in a city or town. Usually applied to manufactured gas (which see); but, in the southwestern U.S., may be natural gas.

CLASSIFYING BED

Produced when a mixture of particles of different densities and/or sizes are fluidized. Uniformity of particle concentration is found only in horizontal planes.

CLINKER

Undesirable agglomeration of ash. Usually in fuel bed or on grate, but can also be on upper surfaces of furnace or boiler. Usually takes the form of a hard fused mass.

CLOSED BURNER

A sealed-in burner which, in most cases, supplies all the air for combustion through the burner itself.

CLOSED CIRCUIT OIL SYSTEM

A system in which oil may be pumped completely through the circulating loop and back into the oil storage tank.

CLOSED IMPELLER

A blower impeller consists of a series of rotating blades or vanes similar to the old-fashioned paddle wheel. The blades of an open impeller rotate between the stationary walls of the blower housing. These walls tend to channel the air so that most of it flows out through the tips of the blades, but some air slips out sideways from between the blades and short-circuits back to the impeller inlet. A closed impeller has cover plate disks attached to the sides of the blades, to minimize short-circuiting.

COAL

A solid, brittle, more or less distinctly stratified, combustible carbonaceous rock, formed by partial-to-complete decomposition of vegetation. Varies in color from dark brown to black. It is not fusible without decomposition, and is very insoluble. Also, a combustible sedimentary rock formed from plant remains in various stages of preservation by processes which involve the compaction of the material buried in basins, initially of moderate depth.

COAL RESEARCH ESTABLISHMENT: See CRE.

COEFFICIENT OF DISCHARGE

A factor used in figuring flow through an orifice. It takes into account the facts that a fluid flowing through an orifice will contract to a cross-sectional area which is even smaller than that of the orifice, and that there is some dissipation of energy due to turbulence.

COKE

Bituminous coal from which the volatile constituents have been driven off by heat, so that the fixed carbon and the ash are fused together.

COKE BREEZE

Coke of a size passing a 5/8-inch screen.

COKE OVEN GAS

Gas saved for use as fuel when coke is made from coal in byproduct ovens. It consists chiefly of hydrogen and methane.

COKING COAL

A coal which, when heated, gives off volatile matter and forms a solid coherent residue.

COMBINATION BURNER

A burner capable of burning either gas or oil. Dual-Fuel (which see) is the North American Mfg. Co. trade name for combination burners.

COMBINED CARBON
Carbon which is chemically combined with oxygen.

COMBINED HYDROGEN
Hydrogen which is chemically combined with oxygen.

COMBINED POWER CYCLE
A power generation cycle combining two different energy cycles. Especially one in which a gas turbine is an integral part of the power producing system. The gas turbine is either supplied from a pressurized boiler exhaust and/or exhausts to a boiler. The boilers supply steam for the steam turbine.

COMBUSTIBLE LOSS
The amount of unburned carbon escaping from the furnace; typically less than 1 percent. Also, the percent of heat input not recovered by the boiler fluid, typically ∿ 10 percent.

COMBUSTIBLES
Materials which can be burned.

COMBUSTION
Burning, or rapid oxidation. Also see -- incomplete combustion and perfect combustion.

COMBUSTION AIR
All of the air supplied through a burner other than that used for atomization. Also called main air.

COMBUSTION BLOCK: See burner refractory.

COMBUSTION EFFICIENCY
The percent of the gross Btu in the fuel fed to the furnace that is absorbed by the fluid, usually > 80 percent. Also, the percent of carbon fed to the furnace that is burned in the furnace, usually > 99 percent.

COMBUSTION PRODUCTS
Matter resulting from combustion, such as flue gases, water vapor, and ash.

COMBUSTION TILE: See burner refractory.

COMPOUND
A distinct substance formed by the chemical combination of two or more elements in definite proportions.

COMPRESSED AIR
Air generally at a pressure of 5 or more pounds per square inch above atmospheric pressure.

COMPRESSED-AIR ATOMIZING OIL BURNER
A burner in which compressed air is used to break the oil stream into a spray of tiny droplets.

COMPRESSIBLE FLOW
Flow of high-pressure gas or air which undergoes a pressure drop sufficient to result in a significant reduction of its density.

COMPRESSIBILITY EFFECT
The change in density of gas or air under conditions of compressible flow.

CONDUCTION
The transfer of heat through a material by passing it from molecule to molecule.

CONDUCTIVITY, THERMAL: See thermal conductivity.

CONTINUOUS-TYPE FURNACE
A furnace operated on an uninterrupted cycle, in which the charge is being constantly added to, moved through, and removed from the furnace. As opposed to a batch-type furnace.

CONTROLLED CIRCULATION BOILER
A boiler in which a pump between the drum and the waterwalls assists natural circulation in causing water and steam to flow through circuits of a steam generating unit. Circuits are usually orificed to distribute flow. Compare with forced circulation boiler.

CONTROL ZONE
The section of a furnace within which temperature is controlled by the throttling action of a single valve.

CONVECTION
Transfer of heat by moving masses of matter. Convection currents are set up in a fluid by mechanical agitation or because of differences in density at different temperatures.

COTTRELL PRECIPITATOR
Trade name for an electrostatic precipitator.

CRACKING OF HYDROCARBONS
The splitting of hydrocarbon molecules into both heavy and light molecules, all lighter than the starting molecules. This results from the application of pressure, a catalyst, heat in the absence of air, or various combinations of the three.

CRE
Coal Research Establishment. A research and development unit of the British National Coal Board.

CRITICAL FLOW

The rate at which a fluid flows through an orifice when the stream velocity at the orifice is equal to the velocity of sound in the fluid. Under such conditions, the rate of flow may be increased by an increase in upstream pressure, but it will not be affected by a decrease in downstream pressure. Also, the rate of flow at which the flow changes from the laminar to the turbulent form.

CROLOY STEELS

Babcock and Wilcox trade name for a series of high-temperature alloy steels used in boiler construction.

CROSS-CONNECTED

A term used to describe two pipes or systems of flow connected to each other, usually to provide an equalization or interplay of pressures.

CRUDE OIL

Unrefined oil in its natural state as it comes from the ground. Also called petroleum, or crude.

CRUSHED COAL

Usually coal which has been crushed for use in a cyclone furnace as opposed to pulverized coal. Normally 90 to 97.5 percent passes a number 4 screen and 7 to 13 percent passes a number 200 screen (fine hole U.S. standard series).

CULM

A vernacular term, variously applied according to the locality to carbonaceous shale or to fissile varieties of anthracite coal. In Pennsylvania, the waste or slack of the anthracite coal mines.

CYCLONE

A separator depending upon centrifugal force to separate particles or droplets from the stream. Used to separate solids from gases, also water from steam.

CYCLONE FURNACE

A type of burner or furnace utilizing crushed coal, a swirling motion of the fuel fed, "wet slag" formation, and a higher pressure drop through the furnace than either P.C. or stoker units. The furnace is readily adaptable to oil or gas firing and multiple fuel use.

DEAD END OF A LINE

The end of a pipe line which does not lead back to storage tank, so that the fluid in that end of the line cannot be recirculated.

DEAD END SYSTEMS

Systems which do not contain a return line to storage tank; therefore, the fluid cannot be pumped around in a closed circuit.

DEAD BURNED
The state of a basic refractory material resulting from a heat treatment that yields a product resistant to atmospheric hydration or recombination with carbon dioxide, SO_2, etc. or, by extension, to any substance. Also, completely calcined.

DEAD WEIGHT RELIEF VALVE
A valve in which the unrelieved weight of the plug is the force which tends to keep the valve shut. The valve opens when the pressure increases sufficiently to lift the plug against the force of gravity.

DEFICIENCY OF AIR
A supply of air which is inadequate for complete combustion of a fuel. This is the same as an excess of fuel.

DEGREES API: See API°.

DEGREES BAUME: See Baume°.

DELAYED MIXING
A process in which the fuel and air leave the burner nozzle unmixed, and thereafter mix relatively slowly, largely through diffusion. This results in a long luminous flame, called a diffusion flame, luminous flame, or long flame.

DENSE PHASE
A fluidized bed is considered a dense-phase fluidized bed as long as there is a fairly clearly defined upper limit or surface to the bed. The dense phase is usually considered to have bed voidage on the order of magnitude of 50 to 70 percent with the position of the solids bed, as a whole, fixed relative to the wall of the confining vessel; i.e., not in transport.

DENSITY
The weight of a unit volume of a substance. Also, specific weight.

DEVOLATILIZATION
Progressive loss of volatiles by the substance undergoing the gasification process. Also, treatment of coal, usually by controlled heating, to remove all or part of the volatile constituents.

DEW POINT
The saturation temperature. The temperature at which moisture or other vapors begin to condense as liquids on surfaces.

DFO
Distillate fuel oil (Grades 1 and 2).

DIESEL CYCLE
A type of energy cycle, represented by a diesel engine. On a pressure/volume diagram, it is shown by isentropic compression, constant pressure heat addition, isentropic expansion, and constant volume heat rejection. The work is the area enclosed by the above.

DIFFUSION FLAME: See delayed mixing.

DILUTE PHASE: See dispersed suspension.

DISCHARGE COEFFICIENT
A factor used in figuring flow through an orifice. It takes into account the facts that a fluid flowing through an orifice will contract to a cross-sectional area which is even smaller than that of the orifice, and that there is some dissipation of energy due to turbulence.

DISENGAGING SECTION
A portion of the fluid bed vessel extending above the dense phase of the fluid bed; frequently enlarged (see freeboard). Also, section in a boiler gas passage where reduced velocity and/or impingement is used to cause particulates to disengage from the gas stream. Also, section in a boiler drum where liquid water is disengaged from the steam flow.

DISPERSED PHASE: See dispersed suspension.

DISPERSED SUSPENSION
That portion of the fluidized mass which has >95 percent voidage. That is, less than 5 percent of the total volume is occupied by particles.

DISSOCIATION
The breaking up of combustion products into combustibles and oxygen, accompanied by an absorption of heat. This usually occurs at high temperatures, and is one of the factors limiting the maximum temperature of a flame.

DISTILLATE OIL
Oil which has been separated from crude oil by fractional distillation.

$/BBL
Dollars per barrel; usually of petroleum.

DOLOMITE
A carbonate of calcium and magnesium, $CaMg(CO_3)_2$. Also, term applied to those rocks that approximate the mineral dolomite in composition. Also, a limestone containing in excess of 40 percent of $MgCO_3$ as the dolomite molecule.

DOLOMITIC(DOLOMITE)LIMESTONE
A limestone containing dolomite, but in which the content of $CaCO_3$ exceeds that of $MgCO_3$.

DOWNCOMER
A pipe to conduct something downward; such as (1) a pipe for leading hot gas from the top of a furnace down to the dust collectors and flue system; and (2) a tube, larger in diameter than the water tubes in some water-tube boilers, to conduct water from each top drum to a bottom drum under the influence of thermal circulation.

DRAFT
A difference of pressure which causes a flow of air or gases into a furnace or chimney.

DRUM
A cylindrical vessel with tubes leading into it. The drum collects the steam produced in the tubes and serves as a manifold for the outgoing steam duct.

DRY ASH
A boiler in which the ash is not fused or slagged.

DRY BOTTOM: See dry ash.

DRY FLUE GAS (dfg)
Gaseous products of combustion exclusive of water vapor. Separation of the vapor from the flue gas (a practical impossibility) is a theoretical concept used in combustion calculations.

DUAL-FUEL BURNER
The North American Mfg. Co. trade name for combination gas-oil burners which are designed for rapid and convenient conversion from one fuel to the other by simply opening and closing valves.

DUTY
The heat transfer capacity per unit time. This may be expressed as pounds of steam per hour at stated conditions.

DYNAMIC VISCOSITY: See absolute viscosity.

ECONOMIZER
That portion of the boiler which uses otherwise lost heat (economizes) to preheat feedwater to the boiler. It is most usually found in the flue gas passages. Some steam may be formed here.

EDR
Equivalent direct radiation: the rate of heat transfer (by both radiation and convection) from a radiator or convector. It is expressed in terms of the number of square feet of surface of an imaginary standard radiator which would be required to transfer heat at the same rate as does the unit in question. One square foot of EDR gives off 240 Btu/hr for steam heating units, or 150 Btu/hr for hot water heating.

EFFICIENCY

The percentage of gross Btu input that is realized as useful Btu output of a furnace. Also, the percentage of gross Btu input to a system realized as useful output.

ELECTROSTATIC PRECIPITATOR

A device which utilizes electrical charging of particles and subsequent deposition on a surface with an opposite charge to remove them from a gas stream.

ELEMENT

One of the 103 or more basic substances of which all matter (compounds and mixtures) is composed.

ELUTRIATE

To be washed or carried from the main body of material by the fluid stream. See elutriation.

ELUTRIATION

An operation whereby a mixture of finely divided solids is separated into its individual size components by subjecting the mixture to the action of a rising current of fluid. Also widely used to indicate entrainment loss--see entrainment.

EMISSIVITY

The ability of a surface to radiate energy as compared with that of a "black body", which emits radiation at the maximum rate possible at any given temperature and which has an emissivity of 1.0.

ENDOTHERMIC REACTION

A chemical reaction accompanied by the absorption of heat. The opposite of exothermic reaction, which see.

ENERGY CYCLE

General term for means of extracting energy from fuel. See specific cycle: Brayton, Carnot, Diesel, Otto, or Rankine.

ENTHALPY

Total heat content, expressed in Btu per pound, above that at an arbitrary set of conditions chosen as the base or zero point.

ENTRAINMENT

The phenomenon in which bed particles are carried from the bed by the fluid and out of the confining vessel. Also used to indicate liquid water carryover in steam.

ENTROPY

A measure of the unavailable energy in a system; that is, energy that cannot be converted into another form of energy. Also, the ratio of amount of heat added to air to the absolute temperature at which it is added. Measured in Btu per degree Reaumur.

EQUILIBRIUM
As applied to a furnace, the condition which exists when its walls have absorbed all the heat they can hold at a specific furnace temperature, so that any further flow of heat to the walls results in an equal amount of heat being transferred to the outside.

EQUIVALENT DIRECT RADIATION: See EDR.

ETHANE
A hydrocarbon gas (C_2H_6) used as a fuel. Frequently a component of natural gas.

EXCESS AIR
The air remaining after a fuel has been completely burned. Also that air supplied in addition to the quantity required for complete combustion.

EXCESS FUEL: See deficiency of air.

EXIT TEMPERATURE
The temperature of flue gases as they leave a furnace.

EXOTHERMIC REACTION
A chemical reaction which liberates heat, such as the burning of a fuel. The opposite of endothermic reaction, which see.

EXPANDED BED
The fluidized bed, which see.

FAN MIXER
An air blower in which gas is admitted to the inlet to be mixed with air.

FBC
Fluidized-bed combustor. A pilot-scale fluidized-bed combustor with provisions for various cooling arrangements. Also, fluid-bed combustors in general.

FBM
Fluidized-bed module. A prototype module which has many of the features and represents the parameters of a module of a large fluidized bed.

FILTER
A porous mass used to remove particles suspended in a fluid. An oil filter, actually a wire mesh strainer, is frequently called a filter.

FINES
In general, the smallest particles of coal or mineral in any classification, process, or sample of material. Especially those which are elutriated from the main body of material in the process.

FIRE TUBE BOILER
A shell boiler, with added heating surface gained from passing hot gases from the fire through the inside of tubes located within the shell.

FIRING RATE
The rate at which air, fuel, or an air-fuel mixture is supplied to a burner or furnace. It may be expressed in volume, weight, or heat units supplied per unit time.

FIXED BED
A bed in which the individual particles or granules of a solid are motionless and supported by contact with each other. Contrast with moving bed.

FIXED CARBON
For coal, coke, and other bituminous materials, the solid residue, other than ash, obtained by destructive distillation, determined by prescribed methods.

FLAME BLOWOFF
The phenomenon which occurs when a flame moves away from a burner. This often results in the flame's being extinguished. A flame blows off when the air-fuel mixture leaves the burner at a velocity greater than the velocity with which the flame front progresses through the mixture.

FLAME FRONT
The plane along which combustion starts, or the base of a flame.

FLAME RETENTION BURNER
A burner whose nozzle is surrounded with small ports which act as pilots to relight the main flame if it blows off. The velocity through the small ports is less, so the flame almost never blows off of them.

FLAME VELOCITY
The speed at which a flame progresses into a mixture relative to the speed of the mixture.

FLAMMABILITY LIMITS
The maximum and minimum percentages of a fuel in an air-fuel mixture which will burn or ignite.

FLASH-BACK
The phenomenon which occurs when a flame front moves back through a burner nozzle (and possibly back to the mixing point). Flash-back occurs because the flame velocity exceeds the velocity with which the air-fuel mixture flows through the burner nozzle.

FLASH POINT

The minimum temperature at which sufficient vapor collects above a liquid oil for it to catch fire if exposed to open flame. The fire point is the minimum temperature at which a flame is sustained for at least 5 seconds.

FLOW COEFFICIENT

A correction factor used for figuring volume flow rate of a fluid through an orifice. This factor includes the effects of contraction and turbulence loss (covered by the coefficient of discharge), plus the compressibility effect, and the effect of an upstream velocity other than zero. Since the latter two effects are negligible in many instances, the flow coefficient is often equal to the coefficient of discharge.

FLUE GAS

All gases which leave the furnace by way of the flue, including gaseous products of combustion, water vapor, excess oxygen, and nitrogen.

FLUE GAS ANALYSIS

A statement of the quantities of the various components of a sample of flue gas, usually expressed in percentages by volume.

FLUE GAS LOSS

The sensible heat carried away by the dry flue gas, and the sensible and latent heat carried away by the water vapor in the flue gas. Also called stack loss.

FLUID

A gas or liquid, as opposed to a solid.

FLUIDIZATION

A condition where the individual particles or granules of a solid are suspended by a gaseous or liquid fluid passing upward through them at a velocity sufficient to cause them to be disengaged somewhat from each other. The system exhibits properties of a liquid.

FLUIDIZED BED

A bed in a state of fluidization, which see. Also called expanded bed.

FLUIDIZING POINT

That point where the rate of fluid flow expands the solid bed sufficiently to allow the granules to move within the bed.

FLY ASH

The solid particles resulting from the combustion of solid or heavy liquid fuels. Especially the ash from pulverized coal firing.

FLY ASH RECYCLE: See cinder return.

FO

Fuel oil.

FORCED CIRCULATION BOILER
One in which the water and steam are forced through the circuits of a steam generating unit by pumps. Controlled circulation (which see) is a special form of forced circulation.

FORCED DRAFT
The difference in pressures which blows air into a furnace, usually produced by a fan located in the inlet air passage to the furnace.

FREEBOARD
The height of the confining vessel extending above the boundary of the expanded fluidized bed. Some dilute-phase reaction and entrained particle disengagement occur in this zone.

FREE CONVECTION: See natural convection.

FRICTION FACTOR
A factor used in calculating loss of pressure due to friction of a fluid flowing through a pipe or conduit.

FSI
Free-swelling index: See swelling number.

FUEL
Any substance used for combustion.

FUEL/AIR RATIO
The ratio of the fuel supply flow rate to the air supply flow rate when both rates are measured in the same units under the same conditions. Also, the ratio of fuel/air expressed as a percent or fraction of stoichiometric.

FURNACE
An enclosed place in which heat is intentionally released by combustion or by electrical devices.

FURNACE PRESSURE
The gauge pressure which exists within a furnace combustion chamber. The furnace pressure is said to be positive if greater than atmospheric pressure, negative if less than atmospheric pressure, and neutral if equal to atmospheric pressure.

FUROL, SAYBOLT: See saybolt furol.

FUSION POINT
Properly, the temperature at which the solid and liquid states of a substance can exist together in equilibrium, but popularly thought of as the melting or freezing point of a substance. See also ash-fusion temperature.

GAGE PRESSURE
The difference between atmospheric pressure and the pressure being measured. Also written "gauge" pressure.

GAS
A form of matter. Also, any gaseous fuel. See specific gas: natural, liquefied petroleum, or manufactured gas. Also see blast furnace, blue, butane, carbureted water, coke oven, high pressure, liquefied petroleum, low pressure, natural, producer, propane, and water.

GAS BOOSTER
A gastight blower used to increase gas pressure.

GAS BURNER
See specific application: flame retention, large port, long flame, nozzle mixing, ported manifold, premix, and small port.

GASIFICATION
Conversion of coal (or oil) to gaseous fuel without leaving a combustible residue. Also applied to intermediate stages of coal conversion, with more or less solid combustible residue (char) left.

GAS GRAVITY
The ratio of the weight of a given volume of a gas to the weight of an equal volume of dry air under the same conditions of temperature and pressure. Also called specific gravity.

GAS MIXER
Any device for mixing gas and air, such as a fan, aspirator, or inspirator.

GAUGE PRESSURE
The difference between atmospheric pressure and the pressure the gauge is measuring. Also written gage pressure.

GRADES OF FUEL OIL
Arbitrary commercial standards recommended by the U.S. Bureau of Standards for different classifications of fuel oils, based on characteristics among which the most important are specific gravity and viscosity. Use is voluntary.

GRAM CALORIE: See calorie.

GRAVIMETRIC ANALYSIS
An analysis based upon the weights of the component parts.

GRAVITY, STANDARD
A gravitational force which will produce an acceleration equal to 32.17 feet per second, per second. The actual force of gravity varies slightly with altitude and latitude. The standard was arbitrarily established as that at sea level and 45 degrees latitude.

GRAY-KING SCALE OR TEST
A British measure of the coking properties of coal. Noncoking is type A; highly coking is type G. A number subscript is assigned to coking types which swell to indicate the degree of swelling.

GRID OR GRID PLATE
The lower support for the bed. Usually the fluidizing medium is passed through here into the bed.

GROSS HEATING VALUE
The total heat obtained from combustion of a specified amount of fuel which is at 60°F when combustion starts, and the combustion products of which are cooled to 60°F before the quantity of heat released is measured. Also called higher heating value.

HARD COAL
In U.S. usage, anthracite or semi-anthracite. In European usage, a coal having a calorific value greater than 10,260 Btu per pound on a moist, but ash free basis.

HDS
Hydrodesulfurization, a copyrighted trademark. Desulfurization by use of hydrogen and catalyst treatment.

HEAD
The pressure difference which causes the flow of a fluid in a system. When applied to liquids, it is usually measured in height of liquid column.

HEADER
A manifold or supply pipe to which a number of branch pipes are connected.

HEAT
See specific application: available, latent, or sensible.

HEAT CONTENT
The sum of latent and sensible heat stored in a substance minus that contained at an arbitrary set of conditions chosen as the base or zero point. It is usually expressed in units of Btu per pound, but may also be expressed in such units as Btu per gallon and Btu per cubic foot if the conditions of pressure and temperature under which these volumes are measured as specified.

HEAT EXCHANGER
A device for transferring heat from one fluid to another.

HEAT FLUX
The rate of flow of heat through a unit area.

HEATING VALUE
The heat released by combustion of a unit quantity of a fuel, measured in calories or Btu.

HEAT OF COMBUSTION
The heat released by combustion of a unit quantity of a fuel, measured either in calories or Btu.

HEAT OF FUSION
Strictly, the heat required to melt (or sublime) a solid at standard pressure. Also used to mean latent heat of vaporization, which see.

HEAT RATE (HR)
The amount of heat (Btu) required as input (fuel) for a net kwh output by the generating plant. In modern plants the range is approximately 8600 to 12,600 Btu/kwh. This reflects all furnace, boiler, turbine, generator, and ancillary equipment losses and consumption. Theoretical or 100 percent efficiency is 3,413 Btu/kwh.

HEAT TRANSFER
Flow of heat by conduction, convection, or radiation. This term is often used to mean heat transfer rate.

HEAVY FUEL OIL
Grades 5 and 6 and Bunker C. These usually are residual oils.

"Hg
Inches of mercury column, a unit used in measuring pressures. One inch of mercury column equals a pressure of 0.491 lb per sq inch.

"Hg ABSOLUTE
Total pressure, including atmospheric, measured in inches of mercury column. One inch of mercury column equals a pressure of 0.491 lb per sq inch. Standard barometric pressure is 29.92 inches of mercury column.

"Hg VACUUM
A scale for measuring pressures less than atmospheric. A reading of zero indicates atmospheric pressure, while 29.92 would indicate no pressure, or a perfect vacuum.

HIGHER HEATING VALUE (hhv): See gross heating value.

HIGH FIRE
A relative term meaning that the input rate to a burner or combustion chamber is at or near maximum.

HIGH PRESSURE GAS
Gas at pressures greater than 2 pounds per sq inch.

HI-SUL
High sulfur content.

HORSEPOWER (hp)
A unit of power equal to 550 foot pounds per second, 33,000 foot pounds per minute, or ~2545 Btu/hr.

HYDRAULIC RADIUS
The cross-sectional area of a flow path divided by its perimeter.

HYDROCARBON
Any of a number of compounds composed of carbon and hydrogen. Sometimes extended to cover CO as in unburned hydrocarbons.

HYDRODESULFURIZATION: See HDS.

IGNIFLUID
A type of furnace invented by Albert A. Godel of France, licensed to Babcock Atlantique, used in Europe and North Africa to burn low grade (high ash) coal. Essentially an inclined travelling chain grate (which see) stoker with a wind box (which see) beneath, through which sufficient air is forced to partially fluidize the coal on the grate; added air is introduced above the grate.

IGNITION
The act of starting combustion.

IGNITION TEMPERATURE
The minimum temperature at which combustion can be started.

IMPELLER: See closed impeller.

IMPACT PRESSURE: See total pressure.

IMPACT TUBE
Also called a pitot tube, which see.

IMPELLER
A blower impeller consists of a series of rotating blades or vanes similar to the old-fashioned paddle wheel.

IMPULSE LINE
A small diameter pipe or tube used to convey pressure from a piping system to a diaphragm- or bellows-operated mechanism.

INCHES OF MERCURY COLUMN
A unit used in measuring pressures. One inch of mercury column equals a pressure of 0.491 lb per sq inch.

INCHES OF WATER COLUMN
A unit used in measuring pressures. One inch of water column equals a pressure of 0.578 ounces per sq inch.

INCOMPLETE COMBUSTION
Combustion in which fuel is only partially burned, and is capable of being further burned under proper conditions. An example is carbon burning to form CO; with more air, it would burn to CO_2.

INDUCED AIR
Air which flows into a furnace through openings because the furnace pressure is less than atmospheric pressure. Also air brought into a furnace by entrainment in a high velocity stream.

INDUCED DRAFT
Draft caused by a furnace exit pressure less than the furnace pressure. It may be produced by natural or artificial means.

INDUSTRIAL BOILERS
Those boilers used by industry for inplant steam raising, usually for process or space heating use. Generally small ($\leq$ 10 MW) or less than 500,000 pounds of steam per hour; at low pressure ($\leq$ 1000 psi) and temperature ($\leq$ 700°F) with little superheat ($\leq$ 50°F). Contrast with utility boilers.

INDUSTRIAL HEATING
The direct application of heat to an industrial process, such as in the metallurgical and ceramic industries; as opposed to domestic, space, process, and power heating. The last two differ from industrial heating in that the formation of steam is an intermediate step.

INERTS
Non-combustible substances in a fuel. Also, non-reactive components of a system.

INFLAMMABILITY LIMITS: See flammability limits.

INPUT RATE
The quantity of heat, fuel, or air supplied per unit time, measured in volume, weight, or heat units.

IN SITU
In the natural or original position; in the place needed; in the same vessel; not transported.

INSPIRATOR MIXER
A mixing device in which a jet of gas is used to entrain primary air at a rate proportional to the gas flow rate.

INSULATION
A material which is a relatively poor transmitter of heat. Used to prevent or limit heat transfer. May be block, plastic, monolithic, or composed of molten slag from the fuel.

INTEGRAL FURNACE
A boiler in which the furnace, or combustion chamber, has been designed and built as an integral part of the boiler.

INTERMEDIATE
That portion of the power demand between the base and peaking loads, which see. Applied to boilers and turbines used to meet this demand.

INTERMITTENT
Sporadic or non-continuous; not regular. Sometimes used, incorrectly, for intermediate, which see.

INTERSTITIAL VELOCITY
The velocity of the fluid (gas or liquid) in the spaces between the particles. This is always greater than the superficial velocity.

IR
Infrared.

ISENTROPIC
Having or indicating constant entropy;taking place without change in entropy. If steam could be expanded in a turbine with no friction or other losses, the expansion would be isentropic.

KILN
A heated chamber used for the burning, hardening, and/or drying stage of an industrial (usually ceramic) process.

KILOGRAM CALORIE: See calorie.

KILOWATT-HOUR(kwh)
A unit of work or heat, equivalent to that resulting from the use of electricity at the rate of 1 k owatt for 1 hour. It is equal to 3412 Btu.

KINEMATIC VISCOSITY (kin. visc)
The relative tendency of fluids to resist flow. The value of the kinematic viscosity includes the effect of the density of the fluid. The kinematic viscosity is equal to the absolute viscosity divided by the density.

LAGGING
A term used to indicate the insulation applied to a boiler or pipe, usually external.

LARGE-PORT BURNER
A burner characterized by a single large discharge opening or nozzle.

LATENT HEAT
Heat absorbed or given off by a substance without changing its temperature. A change of state (e.g., liquid to vapor) is associated with transfer of latent heat.

LATENT HEAT OF FUSION
Heat given off by a liquid freezing to a solid or gained by a solid melting to a liquid, without a change in temperature.

LATENT HEAT OF VAPORIZATION
Heat given off by a vapor condensing to a liquid or gained by a liquid evaporating to a vapor, without a change in temperature.

LEAN MIXTURE
An air-fuel mixture in which an excess of air is supplied, creating a relatively low fuel-to-air ratio.

LIGHT FUEL OIL
Grades 1 and 2, which are distillate fuel oils.

LIGHTUP OR LIGHT-OFF
The entire procedure of igniting a burner or system of burners.

LIGNITE
A brownish-black coal in which the alteration of vegetal matter has proceeded further than peat but not so far as coal. See "Dictionary of Mining Mineral and Related Terms" for exact usage.

LIMESTONE
A sedimentary rock taining calcium carbonate (calcite), calcium magnesium carbonate (dolomite), or any combination of these two carbonates at least to the extent of 50 percent of the rock. If the carbonate is calcite, the rock is a calcitic limestone; if dolomite is also present, it is a dolomitic limestone; or if calcite is absent, it is a dolomite. Also, a bedded sedimentary rock, consisting chiefly of calcium carbonate, which yields lime when burned (calcined). In general, those rocks in which the carbonate fraction exceeds the non-carbonate constituents. Normally, a rock in which the carbonate fraction is composed primarily of calcite. Usage includes under this term dolomitic limestone or dolostone, oolitic limestone, and crystalline limestone.

LIQUEFIED PETROLEUM (L.P.) GAS
Butane, propane, or a mixture of the two, obtained from oil or gas wells, or as a byproduct from the refining of gasoline. It is sold in metal bottles under pressure as a liquid; hence sometimes called bottled gas.

LIQUID ASH REMOVAL: See **wet bottom**

LJUNGSTROM HEATER
A regenerative (which see) heater utilizing a rotor to transfer the sensible heat of the exhaust gases to the incoming air.

LOAD, BOILER
The quantity of steam produced by a boiler, usually measured in lb per hr. The boiler must be capable of producing the guaranteed load. Frequently used to mean the demand placed on the boiler.

LOAD RANGE
The range over which a boiler can be operated in a continuing stable manner. Also applied to a furnace, for which a range of 50 to 100 percent of rated is normal. Also see turndown ratio.

LOCK HOPPER
A feeding device which incorporates a pressure seal, thus enabling solids to be fed into a system with a higher pressure than that existing in the solids storage area.

LOGARITHMIC MEAN TEMPERATURE DIFFERENCE (lmtd)
Defined by the following equation:

$$\text{lmtd} = \frac{(\text{greatest } \Delta T) - (\text{least } \Delta T)}{\log_e \frac{\text{greatest } \Delta T}{\text{least } \Delta T}}$$

ΔT = temperature difference

LONG FLAME: See delayed mixing.

LONG FLAME BURNER
A burner which purposely has poor mixing of fuel and air so that the fuel takes more time to burn, thus producing a long luminous flame. Also called a luminous flame burner.

LOWER HEATING VALUE (lhv)
Also called net heating value, which see.

LOW FIRE
A relative term meaning that the input rate to a burner or combustion chamber is at or near the minimum.

LOW PRESSURE AIR
Air generally at a pressure less than 2 pounds per square inch gauge pressure.

LOW PRESSURE AIR ATOMIZING OIL BURNER
A type of burner which uses a relatively large amount of air at a pressure between 1 and 2 lb per sq inch, with which to atomize the oil.

LOW PRESSURE GAS
Gas at a pressure less than 2 lb per sq inch.

LOW-SUL
Low sulfur content.

L.P. GAS (LPG)
Liquefied petroleum gas, which see.

LUMINOUS FLAME: See delayed mixing.

LUMINOUS FLAME BURNER
Also called a long flame burner. A burner which purposely has poor mixing of fuel and air so that the fuel takes more time to burn, thus producing a long luminous flame.

MAIN AIR: See combustion air.

MAIN CIRCULATING LOOP
The section of an oil handling system which delivers the oil from storage to the circuits and returns the unused oil to the storage tank. Also a similar loop for air, steam, etc.

MAKEUP
That material which must be added to the circulating inventory to maintain it at a constant amount or to "make up" for losses, blow down, purging, etc.

MAKEUP WATER
Water which is added to a boiler, tank, or some other container to replace water which has been lost, thus maintaining the proper water level.

MANIFOLD
A header or supply pipe to which a number of branch pipes are connected.

MANOMETER
A U-shaped tube, with liquid in the bottom of the U, used for measuring gauge pressure or pressure differences of fluids. The U-tube is partially filled with a liquid of density different from that of the fluid being measured. When different pressure lines are connected to the ends of the U-tube, the liquid level rises in the low pressure side, and falls correspondingly in the high pressure side. The difference in height of the two liquid columns is proportional to the difference in pressure, and is measured in inches or centimeters of liquid column.

MANUFACTURED GAS
Any gas made artifically on a large scale for use as fuel.

MATTER
Anything that has mass or weight, and occupies space.

MAX 1% S
Maximum 1 percent sulfur content.

MEAN STACK TEMPERATURE
The average temperature of flue gas in a chimney, sometimes approximated by measuring the temperature of the gases at a point midway between the breeching connection and the top of the chimney.

MECHANICAL DRAFT
A pressure differential produced by machinery, such as a fan or blower.

MECHANICAL PRESSURE ATOMIZING BURNER
A burner in which oil under pressure is permitted to expand through a small orifice, causing the oil to break into a spray of fine droplets.

MEGAWATT (MW)
1000 kilowatt hours. Used to designate boiler and/or plant size and capacity. At generally accepted heat rates, steam temperature, steam pressure, efficiency, and heating values of coal a rough order of magnitude comparison between megawatt rating, coal consumption, and steam production can be drawn as follows:

1 megawatt ~800 lbs coal/hr ~6,400 lbs steam/hr.

MELTING POINT
The sharply defined temperature at which a substance changes from the solid to the liquid state.

MEMBRANE WALL
A type of water-cooled tube wall where the tubes are joined to each other to form a continuous wall or membrane.

METHANE
A gaseous hydrocarbon fuel with formula CH_4. It is a principal component of both natural and marsh gases.

MHD
Magnetohydrodynamics. A direct method of producing power from fuels by combusting at high temperatures and pressures to produce ions and plasma; and thus electrical power. Not yet (1972) reduced to commercial practice.

MM BBL/CD (or MMBCD)
Million barrels per calendar day.

MM$
Millions of dollars.

MINERAL MATTER
Inorganic elements or compounds found in a natural state. As far as combustion is concerned, mineral matter, water, inert gases, and oxygen comprise the non-combustible parts of fuels. Thus all ash is mineral matter.

MINIMUM FIRING RATE
The lowest input rate for a burner or a process which permits stable operation.

MIXER, GAS
A device used to mix gas and air before delivery to a burner, such as an aspirator, an inspirator, or a fan mixer.

MIXTURE, LEAN
An air-fuel mixture containing too much fuel or too little air for perfect combustion.

MODULATING CONTROL

Specifically, proportional control. But sometimes used to refer to any system of automatic control which provides an infinite number of control positions, as opposed to systems with a finite number of positions such as two-position control. In industrial heating, modulating control is often used to adjust the fuel and air rates to correct for the difference between the actual temperature in a furnace and the temperature desired.

MOLLIER CHART

A chart, with entropy per weight as an abscissa and enthalpy per weight as ordinate, with properties of the fluid (steam) plotted as a family of curves varying in constant temperature, moisture, °F superheat, and pressure.

MOLECULE

The smallest part of a compound which retains the properties of that compound.

MONOTUBE BOILER: See Sulzer boiler, and Universal Pressure (UP).

MOVING BED

A body of solids in which the particles or granules of a solid remain in mutual contact, but in which the entire bed moves in piston-like fashion with respect to the containing walls. Contrast with fixed bed.

MUD DRUM

A boiler drum at a low elevation to receive all impurities deposited from the water, and so placed as to be removed from the action of the fire.

MUFFLE

A muffle is a chamber within a furnace where the products being heated are kept out of direct contact with the combustion processes.

NAPCA: See OAP.

NATURAL CIRCULATION BOILER

A boiler in which the difference in density between steam and water is the means by which water and steam flow through the circuits of a steam generating unit.

NATURAL CONVECTION

Transfer of heat by currents set up in fluids by differences of density resulting from differences in temperature. Also called free convection.

NATURAL DRAFT
A difference in pressure resulting from the tendency of hot gases to rise up a chimney, thus creating a partial vacuum in the furnace.

NATURAL GAS
Any gas found in the earth, as opposed to manufactured gases. Usually, methane of fairly high (~90 percent)purity.

NCB
National Coal Board (British).

NDIR
Non-dispersive infrared.

NET HEATING VALUE
The gross heating value minus the latent heat of vaporization of the water vapor formed by the combustion of the hydrogen in a fuel. For a fuel containing no hydrogen, the net and and gross heating values are the same. Also called lower heating value.

NO_x
Nitrogen oxides; principally NO and NO_2.

NORMAL THREAD ENGAGEMENT
The amount of overlap, usually measured in inches, necessary to ensure a tight connection between threaded pipes and fittings.

NOZZLE MIXING BURNER
A burner in which the fuel and air are not mixed until just as they leave the burner port, after which mixing is usually very rapid. The flame cannot flash back in this type of burner.

NSG
No sulfur guarantee; i.e., no guarantee as to minimum or maximum amount of sulfur in fuel.

NUCLEAR GLOSSARY
See in Steam 27-13 (Steam, Its Generation, and Use. The Babcock and Wilcox Company, 5th printing or later of 37th edition).

OAP
Office of Air Programs, formerly APCO (Air Pollution Control Office) successor to NAPCA (National Air Pollution Control Administration). Once part of OAP, the Control Systems Division is now part of the Office of Research and Monitoring.

OCR
Office of Coal Research, under the Department of the Interior, sponsors and directs coal research in combustion, gasification, etc.

OGJ
Oil and Gas Journal.

OIL

A general term given to various mixtures of natural hydrocarbons. Also, crude petroleum.

OIL PRESSURE ATOMIZING BURNER

A burner in which oil under pressure is allowed to expand through a small orifice, causing the oil to break into a spray of fine droplets. This type is also called a mechanical pressure atomizing burner.

ONCE-THROUGH BOILER

A boiler in which the working fluid (water) makes one fact uninterrupted trip from the feedwater inlet to the turbine inlet; there is no drum. Babcock & Wilcox types are "Universal Pressure." Combustion Engineering types are "Combined Circulation." See also Benson boiler.

ON-OFF CONTROL

A control which turns the input on or off, but does no proportioning or throttling as is the case with a modulating control.

OPEN IMPELLER: See closed impeller.

OPEN PASS (OP) BOILER

Derives its name from the manner of gas flow, where the gas from the furnace flows through open "thoroughfares" or "passes" before entering the convection passes.

OPEN-TYPE BURNER

The opposite of a sealed-in burner. An open-type burner is surrounded by an air register through which secondary air can enter the furnace.

OPTIMUM AIR SUPPLY

The quantity of air which will give greatest thermal efficiency under actual conditions. With perfect mixing of fuel and air, the optimum air supply is equal to the chemically correct amount of air.

ORIFICE

Literally any opening, but used in this field to designate a construction in a passage, circular in shape unless otherwise specified.

ORSAT ANALYZER

An apparatus used to determine the percentages (by volume) of CO_2, O_2, and CO in flue gases. The difference between the total volume and the sum of the above is usually taken as N_2.

OTTO CYCLE

A type of energy cycle, represented by the gas engine. On a pressure/volume diagram, it is shown by isentropic compression, constant volume heat addition, isentropic expansion, and constant volume heat rejection. The work is the area enclosed by the above.

OUTDOOR INSTALLATION

A boiler installation in which the boiler and furnace are outside, and only the boiler controls area is housed.

OVERALL BOILER EFFICIENCY
The ratio of the useful heat in the delivered steam to the gross heat in the fuel supplied.

OVERFIRE: See stokers, overthrow and overfeed types.

OVERFIRE (OVERSHOOT) AIR
Air introduced over or above the initial combustion zone.

OVERLOAD OF MOTORS
An electric motor is overloaded when a torque greater than that for which it was designed is applied. This slows the motor, causing it to draw too much current, which breaks down the insulation, resulting in a burned out motor.

OVERRATE FIRING
Firing a boiler at an input rate in excess of its rated capacity. The rated capacity of a boiler is based upon its heat transfer surface area only.

OVERTHROW STOKER: See spreader stoker.

OXIDIZING ATMOSPHERE
A furnace atmosphere with excess air (oxygen), thus tending to oxidize materials placed in it.

OXIDIZING FIRE: See oxidizing flame.

OXIDIZING FLAME
A "lean" flame or fire; that is, one resulting from combustion of a mixture containing too much air and too little fuel. This kind of flame produces an oxidizing atmosphere. Also called an oxidizing fire.

PACKAGE-TYPE BOILER
A unit which is mostly, if not entirely, assembled in the plant shop with little or no erection or welding in the field. The unit is shipped as a package.

PAD
Petroleum Administration for Defense. Used, in conjunction with areas delineated by PAD, to tabulate oil production and consumption.

PARTICLE BARRIER
A screen or barrier of tubes or other surfaces, at or just above the upper boundary of the fluidized-bed dense phase. This barrier reduces the freeboard needed to prevent excessive entrainment, and can also provide added heat transfer surface. In slang, a stop-slop screen.

PARTICULATE FLUIDIZED BED

A bed in such a condition of fluidization that the individual particles are discretely separated from each other, and the volumetric concentration of solid particles is uniform throughout the bed.

P.C.

Pulverized coal. Approximately 70 percent of -200 mesh is accepted size for pulverized coal. Also called powdered coal.

PEAK (PEAKING)

Denotes low usage rate, may be at near maximum capacity, but is used $\leq\sim$ 20 percent of the time. Used to identify those boilers and/or turbines which supply the peak increment, or the short-duration, high-demand amount of power above the base and intermediate increments, which see.

PEBBLE HEATER

A regenerative type heater utilizing rocks or pebbles to capture heat from an exit stream and transfer the heat to an incoming stream.

PER

Pope, Evans & Robbins, a division of Perathon, Inc., consulting engineers and EPA/OCR contractor.

PERCENT AIR

The actual amount of air supplied to a combustion process, expressed as a percentage of the amount theoretically required for complete combustion.

PERCENT EXCESS AIR

The percentage of air supplied in excess of that required for complete combustion. For example, 120 percent air equals 20 percent excess air.

PERCENT OXYGEN, % O_2

That percent oxygen present in a gas, usually volume percent. Normally % O_2 is 21 percent of the excess air; e.g., 3 percent O_2 in the flue gas corresponds to ~15 percent excess air.

PERFECT COMBUSTION

The combining of the chemically correct proportions of fuel and air in combustion so that the fuel and oxygen are both totally consumed.

PERFECT GAS

Any gas for which the quantity Pv/T is a constant over a wide range of conditions (where P is the absolute pressure, v is the specific volume, and T is the absolute temperature). There is no "perfect gas", but many gases such as oxygen, nitrogen, and hydrogen, obey this law very closely over a wide range of temperatures and pressures, and so are often called perfect gases, as opposed to vapors which don't obey Boyle's law so closely.

PETROLEUM

Material occurring naturally in the earth composed predominantly of mixtures of chemical compounds of carbon and hydrogen with or without other non-metallic elements. Petroleum may contain or be composed of such compounds in the gaseous, liquid, and/or solid state.

P.F.

Pulverized fuel, usually coal.

PHOTOCELL FLAME DETECTOR

A device which generates or rectifies an electric current while exposed to the light from a flame. Failure of the current or lack of rectification may be used to trip shut a safety shutoff valve.

PILOT

A small gas flame used to light a burner. A continuous pilot (sometimes called constant, standby, or standing pilot) burns throughout the entire period that the furnace or oven is in service whether or not the main burner is firing; an interrupted pilot (sometimes called ignition pilot) burns during the flame-establishing period and/or trial-for-ignition period, and is cut off (interrupted) at the end of this period; and an intermittent pilot burns during "lighting-off" and the entire period that the main burner is firing, and is shut off with the main burner. Also applied to electrical devices used to ensure ignition and to maintain flame.

PIPELINE GAS

A gaseous fuel (usually manufactured) of heat content (∿900 Btu/SCF) and quality comparable to natural gas, and which can be used in combustion as natural gas is used.

PITCH

Orientation of tubes with respect to each other and flow path. Usually given with dimension center to center, following tube size. Such as "1-inch tubes square pitch on 3-inch centers."

PITOT TUBE

A tube with an open end immersed in a stream, and pointed upstream. The other end of the tube is connected to a pressure gauge, which then indicates the total pressure due to the "ram effect" of the flow. Named after a French physicist, Henry Pitot (1695-1771). Also called an impact tube.

PLASTIC CHROME ORE

A plastic insulation usually applied over studded tubes in the combustion zone of a boiler. It "cures" to a monolithic type insulation.

POISE

A metric unit for measuring absolute viscosity. One poise equals 1 dynesecond per square centimeter, or 1 gram per centimeter second. From a physicist named Poiseuille who, in 1842, laid the groundwork for the deduction of coefficients of viscosity.

POLAROGRAPHIC
Used to denote analytical instruments which sense by changes in the electrical properties of the vapor, of a solution in which the vapor is dissolved, or of the oxidized vapor.

PORT
An orifice or opening. May also apply to an access hatch or opening in boiler settings.

PORTED MANIFOLD-TYPE BURNER: See small port burner.

POSITIVE DISPLACEMENT PUMP
Any type of pump in which leakage is negligible, so that the pump delivers a constant volume of fluid, building up to any pressure necessary to deliver that volume (unless of course the motor stalls or the pump breaks).

POURING TEMPERATURE
The customary temperature at which molten metals are poured in industrial processes. Also, the temperature at which ash may be tapped from the furnace. See ash fusion temperatures.

POUR POINT
That temperature of an oil, below which it will not flow satisfactorily. Usually determined by an ASTM procedure.

POWDERED COAL: See pulverized coal.

POWER
The rate of transfer of energy. Also, electricity or electric power. Also, a magazine published for the electric industry.

PREHEATED AIR
Air heated prior to its use for combustion. Frequently the heating is done by hot flue gases.

PREMIX BURNER
Usually a burner supplied with gas and air which has previously been mixed. Sometimes a burner within which the gas and air are mixed before they reach its nozzle (as opposed to a nozzle mixing burner). By extension, a like burner for P.C.

PREMIXER
A device used to mix gas and air before delivery to a burner, such as an aspirator, an inspirator, or a fan mixer. Also a device to mix coal and additive before delivery to the combustion zone.

PRESSURE CONTROL
A system for control of air/fuel ratios by proportioning the pressures in the air and fuel supply lines.

PRESSURE DROP
The difference in pressure between any two points along the path of flow of a fluid. Also, as above, through a fluid bed. See pressure loss.

PRESSURE LOSS
Pressure drop, often unintentional.

PRESSURE REGULATOR
Sometimes called a pressure-reducing regulator. A device used to maintain a constant pressure in a fuel supply line regardless of the flow. It cannot maintain a pressure greater than its inlet pressure.

PRESSURIZED WATER REACTOR (PWR)
A type of nuclear reactor (boiler).

PRIMARY AIR
In this field, all air supplied through the burner, including atomizing and combustion air. Also, all air supplied to the combustion zone.

PRODUCER GAS
An artificial fuel gas of low-Btu content made by passing a mixture of air and steam through a hot bed of coke or coal.

PROPANE
An easily liquefiable hydrocarbon gas (C_3H_8). Propane is one of the components of raw natural gas, and it is also derived from petroleum refining processes.

PROPORTIONAL CONTROL
A mode of control in which there is a continuous linear relation between value of controlled variable and position of final control element.

PROPORTIONING
In combustion engineering, this term applies to the maintenance of the desired ratio between fuel and air supply.

PROXIMATE ANALYSIS (COAL)
An analysis of coal to determine moisture, volatile matter, and ash, and the calculation of fixed carbon by difference.

PULVERIZED COAL
Coal that has been reduced to a fine dust (75 to 95 percent will pass a 200-mesh screen) by grinding mills. Contrast with Crushed Coal.

PURGING
Eliminating an undesirable substance from a pipe, piping system, or furnace by flushing it out with another substance, as in purging a furnace of unburned gas by blowing air through it.

PURITY
As applied to steam, a measure of the freedom from solids content.

PWR
Pressurized water reactor, which see.

PYRITES
Iron pyrite (FeS_2), usually found in coal. Also, other metallic pyrites.

PYROLYSIS
Chemical decomposition by the action of heat, in the absence of air or oxygen.

QUALITY
As applied to steam, a measure of the percent by weight of dry steam or moisture in the mixture.

RADIANT BOILER (RB)
Derives its name from the fact that the heat absorption of the saturated (wet) surface is largely by radiant energy transfer.

RADIATION
A mode of heat transfer in which the heat travels very rapidly in straight lines without heating the intervening space. Heat can be radiated through a vacuum, through many gases, and through a few liquids and solids.

RANK
A classification of coal by age, under the ASTM System; fixed carbon and calorific values on a mineral-matter-free basis are the basic criteria.

RANKINE CYCLE
A type of energy cycle which closely defines current steam power practices. On a pressure/volume diagram the two constant-pressure phases of admission and exhaust are connected by an isentropic expansion line. The work lies between these points and the ordinate.

RATIO REGULATOR
A proportional control device which regulates the downstream pressure in the pipeline in which it is located. It is used to maintain proportional pressures in fuel and air lines in a pressure control system, thus producing proportional flow of fuel and air.

RATIOTROL
The North American Manufacturing Company's trade name for an air/oil ratio regulator.

RB: See radiant boiler.

RÉAUMUR
Relating or conforming to a thermometric scale on which, under standard atmospheric pressure, the boiling point of water is 80° above the zero of the scale and the freezing point of water is at 0. To convert to degrees Centigrade,multiply degrees Reaumur by 5/4.

RECIRCULATING-TYPE OIL SYSTEM
A closed-circuit oil system in which the oil not used at the burners is returned to the storage tank. It is good practice to use only a relatively small portion of the oil pumped, so that turning on additional burners will not cause an excessive pressure drop, and so that heated oil will stay warm.

RECTIFICATION
The process of converting an alternating current to a pulsating direct current.

RECUPERATIVE
Directly using an otherwise waste heat source, usually applied to a preheater used to recover heat from flue gas or non-condensing exhaust and supply this heat directly to either feedwater or incoming air by means of a heat exchanger.

RECUPERATOR
A piece of equipment which makes use of hot flue gases to preheat air for combustion. The flue gases and air flow in adjacent passageways (usually in opposite directions). The heat is thus transferred from the gases, through the separating wall, to the air.

RECYCLE RATIO (RATE)
The recycle ratio is the amount recycled or returned to the system compared to the total in the streams. The recycle rate is the amount, usually weight per time, returned to the system. For example, 100 percent recycle of ash means all ash collected from the gas stream is returned to the furnace. This then can be expressed as X pounds of ash per hour returned to the furnace.

REDUCING ATMOSPHERE
A furnace atmosphere which tends to remove oxygen from substances placed in the furnace. It may be produced by supplying inadequate air to the burners, thus intentionally making the combustion incomplete.

REDUCING FLAME
Also called a reducing fire. A rich flame or fire; that is, one resulting from combustion of a mixture containing too much fuel and too little air. This kind of flame produces a reducing atmosphere.

REFRACTORIES
Highly heat resistant materials used to line furnaces, kilns, ovens, and combustion chambers.

REFRACTORY BLOCK: See burner refractory.

REFRACTORY TILE: See burner refractory.

REFUSE
The solid material remaining after combustion. It consists of ash and unburned solid fuel.

REG
Regular grade, used in petroleum and oil descriptions.

REGENERATION
Renewal of the original properties or restoration of activity. For limestone and dolomite, the removal of sulfur and the restoration of sulfur capture ability.

REGENERATIVE
Applied to a system or device in which heat sinks, such as refractory passages (or large metal masses), are alternately exposed to hot gases, usually waste combustion products, and cold incoming streams, usually air, thus causing the sensible heat of the waste gases to be transferred to the heat sink and thence to the incoming stream. Also a process which utilizes regeneration (which see) of sorbent catalyst, etc.

REHEAT
Addition of heat to steam from a turbine exhaust to permit use of the steam in another turbine.

REHEAT CYCLE
A modification of the simple Rankine cycle. The steam is expanded to an intermediate pressure; it is then reheated to an elevated temperature near the initial temperature, and expansion proceeds isentropically to the exhaust pressure.

REINJECTION
Used to refer to the return or recycle of material removed or carried from the combustion vessel to the vessel. Said of fly ash collected and returned to the furnace, sometimes as a percent of the total collected. See recycle.

RELIEF VALVE
A valve which opens at a designated pressure and bleeds a system in order to prevent a buildup of excessive pressure which might damage regulators and other instruments. Also, as above, to prevent boiler failure from overpressure.

RESIDUAL OILS
Oils which are too heavy to be evaporated in any normal evaporation and distillation process and so are left over from that process. See also heavy fuel oil.

RESISTANCE
As applied to fluid flow, the opposition to flow which makes it inevitable that there will be a pressure drop when a fluid is flowing.

RETURN LINE
The low-pressure side of main circulating loop or branch circuit. That is, that part of an oil circulating system through which the unused oil flows back to the storage tank after having passed the burners. Also, as above for other fluids or materials.

REYNOLDS NUMBER
The ratio of inertial forces to viscous forces in a flowing fluid. When the Reynolds number has been calculated, the friction factor may be determined.

RFO
Residual fuel oil. In strict sense, Grades 4,5, and 6. Often includes bunker "C" and others.

RICH MIXTURE
An air/fuel mixture containing too much fuel or too little air for perfect combustion.

RILEY STOKER: See underfeed stoker.

RISER
A pipe to conduct something upward; such as (1) a pipe for leading a steam/water mixture from the bottom boiler drum to the top of steam drum; and (2) a duct for flue gases or other products of combustion.

ROAST: See calcine.

ROTARY CUP OIL BURNER: See centrifugal atomizing burner.

ROTARY PLUG VALVE
A type of valve in which a ported sleeve or plug is rotated past an opening in the valve body.

SAFETY SHUTOFF VALVE
A valve which automatically and completely shuts off the supply of fuel to a burner or set of burners in case of any irregularity causing flame failure. This prevents the accumulation of unburned fuel in the combustion chamber.

SATURATED AIR
Air which contains all the water vapor it can hold under existing conditions.

SATURATED STEAM
Steam at the boiling point temperature for water at the existing pressure.

SATURATION PRESSURE
The pressure at which a vapor confined above its liquid will be in stable equilibrium with it. Below saturation pressure, some of the liquid will change to vapor; above saturation pressure, some of the vapor will condense to liquid.

SATURATION TEMPERATURE
The boiling point of a liquid for the existing pressure.

SAYBOLT FUROL
A scale used for measuring the viscosity of heavy oils. The instrument has a larger orifice and is used at a higher temperature than the Saybolt Universal instrument used for lighter oils.

SAYBOLT UNIVERSAL
A scale used for measuring the viscosity of oil, expressed in seconds required for a specified amount of oil to flow through an orifice; hence the larger the number of seconds, Saybolt Universal (SSU), the more viscous the oil.

SCALE
A deposited material on heat transfer surfaces, usually on the water or steam side. Corrosion or slag is the term usually applied to fire-side deposits.

SEALED-IN BURNER
A burner mounted on a furnace in an airtight manner so that there can be no inflow of secondary air around the burner.

SECONDARY AIR
In this field, secondary air is all of the air that is intentionally allowed to enter the furnace, but which does not pass through the burner nozzle or grid plate. Also, air introduced above or beyond the primary combustion zone.

SENSIBLE HEAT
Heat, the addition or removal of which results in a change in temperature, as opposed to latent heat.

SERIES RESISTANCES
Resistances through which a fluid flows consecutively. Also, similar for heat flux.

SETTING(S)
The physical surroundings or enclosures. By common usage "boiler setting" has been extended to include the physical surrounding of the boiler and its auxiliaries. In the limited sense, applied to the enclosures, chiefly walls, of complete steam-generating units.

SETTLED BED. See static bed.

SHAPE FACTOR
The fraction of radiation from one surface which falls upon another.

SHELL-TYPE BOILER
A closed vessel containing water, with a portion of the shell exposed to a source of heat.

SHOCK LOSS
If, in converting fluid velocity to static pressure, the fluid is stopped or slowed down too rapidly, some of the energy of fluid velocity is converted to useless heat instead of the desired static pressure. This is called shock loss.

SHUTDOWN
The total process of terminating operation of a combustion system.

SIMULTANEOUS GAS-OIL BURNER
A burner that burns gas and oil at the same time.

SINTER
A coherent, imporous conglomerate material; also to cause or become such a mass by heating without melting.

SLACKING
Size degradation of coal due to weathering or outside storage.

SLAG
Ash and other residue remaining after fuel combustion, usually used to indicate a hot molten state; or, solidification from this state.

SLAG TAP: See wet bottom.

SLUGGING
For fluid bed, the condition in which bubbles of the gas coalesce to a size approaching the diameter of the confining vessel. Some parts of the bed may act as a moving bed (which see). Slugging gives erratic effects on yields, temperatures, etc.

SMALL PORT BURNER
A manifold containing many small holes through which a gas-air mixture flows, and outside of which the mixture burns, such as a domestic gas stove burner. Also called a ported manifold burner.

SOFT COAL: See bituminous coal.

SOOT
A black substance, consisting mostly of very small particles of carbon, which appears in smoke resulting from incomplete combustion.

SOOT BLOWERS
Devices for removing or blowing soot, ash, and slag from boiler convection surfaces. They may use steam, air, or (in special cases) water; may be hand-held lances or automatic devices.

SOUR GAS
Gaseous fuel which contains a relatively large proportion of sulfur or sulfur compounds.

SO_x
Sulfur oxides, principally SO_2 with some SO_3 and other oxides present.

SPACE HEATING
Heating large volumes of air to the temperatures desired for human occupancy or for storage.

SPECIFIC GRAVITY OF GASES: See gas gravity.

SPECIFIC GRAVITY OF LIQUIDS
The ratio of the density of a liquid to the density of water at standard conditions of temperature and pressure.

SPECIFIC HEAT
The amount of heat, measured in Btu, required to raise one pound of a substance through one degree Fahrenheit.

SPECIFIC VOLUME
The volume occupied by one pound of a substance under any specified conditions of temperature and pressure.

SPECIFIC WEIGHT: See density.

SPOUTING BED
A fluidized-type bed where the fluidizing medium enters the bed through a single opening of a cross section much smaller than that of the bed. The fluid carries particles to the top only in its central core, whereas, at the walls the particles move downwards, as in a moving bed.

SPREADER STOKER
A type of stoker with two subgroups--underthrow and overthrow; the latter is preferred. A rotor is used to spread the fuel on the grate: the overthrow type ejects the fuel at the top tangent point; the underthrow ejects at the bottom tangent point. Grates may be of several types, all with a basic design concept of high resistance with air metering to avoid blow holes through the thin fuel bed.

SPUD
A gas, air, or fuel orifice. A small hole, drilled to a specific size, for the purpose of limiting flow to the desired rate.

STABILITY
That quality of a burner enabling it to remain lighted over a wide range of fuel/air mixture ratios when its surroundings are at room temperature.

STACK DRAFT, THEORETICAL
The suction that would be produced at the base of a stack with no flow losses. This results from the difference between the specific weights of the surrounding atmospheric air and the stack gases.

STACK EFFECT
The difference in pressure caused solely by the difference in elevation between two stations in vertical ducts or passages conveying heated gases.

STACK GAS: See flue gas.

STACK LOSS: See flue gas loss.

STAGNATION PRESSURE: See total pressure.

STANDARD AIR
Air at standard temperature and pressure; i.e., 60°F and 29.92 inches of mercury.

STANDARD ATMOSPHERE
The accepted normal atmospheric pressure at sea level, equal to 14.696 lb per sq inch. The same as standard pressure.

STANDARD BAROMETER
The reading of a barometer for standard atmospheric pressure; equal to 29.92 inches of mercury column.

STANDARD GRAVITY
Standard accepted value for the force of gravity. It is equal to the force which will produce an acceleration of 32.17 ft per sec per sec.

STANDARD PRESSURE: See standard atmosphere.

STANDARD TEMPERATURE
In combustion and boiler fields, standard temperature is 60°F.

STANDARD VOLUME
The volume of a gas or air measured at 29.92 inches of mercury pressure and 60°F temperature.

STATIC BED
The bed with no fluidizing medium passing through it, usually applied to bed height measurements taken under non-fluidized conditions. Also called settled bed. Also applied to beds with fluidizing medium passing through the bed at a rate insufficient to fluidize the bed.

STATIC PRESSURE
The force per unit area exerted by a fluid upon a surface at rest, relative to the fluid. For fluid flowing in a pipe, static pressure is measured by a gauge connected to the side of the pipe, perpendicular to the direction of flow.

STEAM ATOMIZING BURNER
A burner which uses high pressure steam to tear droplets of oil from the main oil stream and propel them into the combustion space so rapidly that they vaporize quickly.

STIRLING BOILER
Early tube-and-drum or bent-tube type boiler, named for Allan Stirling circa 1880. Also applied to modern improved boiler derived from the early boilers.

STOICHIOMETRIC MIXTURE
A chemically correct mixture of fuel and air; i.e., a mixture capable of perfect combustion.

STOKE

The cgs unit of kinematic viscosity. One stoke equals one centimeter squared per second. From Sir George Gabriel Stokes (1819-1903), British mathematician and physicist who is noted for his work on the friction of fluids in motion.

STOKERS

Devices used to introduce solid fuel into the combustion zone. Most fall into one of three groups, based on direction and method by which the fuel reaches the grate:

1. Overfeed: chain grate, traveling grate, vibrating grate, and oscillating grate.
2. Spreader.
3. Underfeed.

STOP-SLOP SCREEN

Slang, non-preferred term. See particle barrier.

STP FLOW RATE

The rate of flow of a fluid, by volume, corrected to standard temperature and pressure.

STP VOLUME

The volume which a quantity of gas or air would occupy at standard temperature and pressure.

STRAIGHT-TUBE BOILER

A boiler in which the water and steam tubes are substantially without bends.

STRAINER

A fine mesh screen used to separate foreign particles from an oil stream, or other streams.

STUDS, STUDDED TUBE

Metal projections welded to boiler tubes to provide increased heat transfer and to provide support.

SUCTION LINE

In this field, that part of an oil circulating system between the pump and the oil storage tank. Also, pump intake line for any fluid.

SUCTION TYPE MIXER: See aspirator mixer.

SULZER BOILER

A special type of a once-through boiler, used for both subcritical and supercritical steam pressures. Also called a monotube boiler.

SUPERCRITICAL PRESSURE

A boiler which produces steam above the critical pressure (3206 PSIA).

SUPERFICIAL VELOCITY
The velocity of the fluid (gas or liquid) in the free (without bed particles) cross section of the vessel.

SUPERHEAT, SUPERHEATER
Heat in or temperature of steam over and above that of the saturation temperature at that pressure, usually given as so many degrees (°F) superheat. That part of the boiler in which vapor (steam) is further heated.

SWELLING NUMBER
A numerical expression to indicate the relative swelling properties of a sample when heated under standardized conditions as specified in ASTM D-720. Also known as free-swelling index or FSI. Zero (0) is no swelling, no coherent residue; 9 is the greatest swelling, with coherent residue.

SWING
The change or rate of change in a power demand over a period of time.

TAIL GAS
Used to denote the effluent from a process, such as H_2SO_4 manufacture or ore roasting. Also that effluent from a final stage, as from a flue gas scrubber.

TAKE-OFF LINES
Pipelines leading from the high pressure side of the main circulating loop to the branch circuits. Also, supply lines to burners.

THEORETICAL AIR
The chemically correct amount of air required for complete combustion of a given quantity of a specific fuel. Also, stoichiometric air.

THEORETICAL DRAFT
The calculated difference between the pressure in a furnace and the atmospheric pressure, which is caused by the buoyancy of the hot gases in the furnace and its chimney. Theoretical draft does not include the effects of friction or conditions other than standard.

THERMAL CONDUCTIVITY
The ability of a material to conduct heat, measured in rate of heat flow in Btu per hour through a square foot of cross-sectional area and 1 foot (or 1 inch) of thickness when the temperature difference across this thickness is 1 degree Fahrenheit.

THERMAL EXPANSION
An increase in the volume of a substance resulting from a rise in its temperature.

THREE MONTHLY REPORT
British usage for quarterly report.

THROTTLING VALVE
A valve used to control the flow rate of a fluid. A throttling valve does not necessarily provide tight shutoff.

TIE BAR
A structural member which ties the tubes forming the boiler wall together.

TOP HEAT POWER CYCLE
An advanced cycle in which the steam temperature is raised by directly adding the products of clean fuel combustion to the steam.

TOPPING UNIT
May be applied to boiler and/or turbine. Designates a unit which uses or produces steam (or gas) at a high temperature and pressure, the topping turbine exhaust being directed to turbines which utilize a lower pressure and/or temperature steam or gas. The exhaust steam may also be reheated and/or mixed with other steams.

TOTAL PRESSURE.
The pressure measured by an impact tube. It is the sum of the static pressure and the velocity pressure. The total pressure of a motionless fluid is equal to its static pressure. Also called impact pressure or stagnation pressure.

TOWN GAS: See city gas.

TRANSPORT AIR
That air used to transport and inject solid fuel into the combustion space. Compare with atomizing air for liquid fuels.

TRAVELING GRATE
A type of stoker differing from a chain grate (which see) only in that there is no relative motion between the adjacent sections at the return bend.

TRIP, TRIPPED
Indicates dropping or loss of load on a unit, usually turbine/generator set. May be caused by any of several malfunctions (such as excessive vibration, loss of oil pressure, or loss of steam pressure to turbine), any of which "trip" a switch to remove the generator from the power grid, and halt steam flow to the turbine.

TURBO BLOWER
A type of centrifugal blower in which the air leaving the blade tips passes through a narrow slot into a large volume chamber, thus efficiently converting velocity energy to static pressure.

TURBULENCE
A state of being highly agitated. Turbulent flow is fluid flow in which the velocity of a given particle changes constantly both in magnitude and direction.

TURBULENT FLUIDIZED BED
A fluidized bed in a state of fluidization above the minimum fluidizing point, and in which the particles tend to mix readily.

TURNDOWN RATIO
The ratio of maximum to minimum input rates, for stable sustained combustion.

TUYERE
A tube or opening through which air (or fuel) is introduced into the vessel.

ULTIMATE ANALYSIS
A statement of the quantities of the various elements of which a substance is composed, usually expressed in percentages by weight. Also, see ultimate analysis (coal).

ULTIMATE ANALYSIS (COAL)
An analysis of a dried coal sample to determine carbon, hydrogen, sulfur, nitrogen, and ash with oxygen estimated by difference.

ULTIMATE CO_2
The percentage by volume of carbon dioxide which appears in the dry flue gases when a fuel is completely burned with its chemically correct air/fuel ratio. It is the theoretical maximum percent CO_2 which it is possible to obtain.

UNDERFEED STOKER
A type of stoker (typically a Riley make) which can be either a horizontal feed or a gravity feed. Coal, force fed (or gravity fed) to the fuel bed from beneath, forces the fuel bed up and consequently to the side, where the ash is withdrawn. Also, an arrangement where the bed moves to the rear of the furnace.

UNDERFIRING
As used by Esso, England, burning fuel beneath the distribution grid of the fluidized bed.

UNDERTHROW STOKER: See spreader stoker.

UNIT TRAIN
The practice of using a complete train of rail cars to move coal from the mine to the generating station and returning the train as a unit to the mine for subsequent loads.

UNIVERSAL PRESSURE (UP)
The name used by Babcock and Wilcox to designate a once-through boiler suitable for either subcritical or supercritical steam raising.

UNIVERSAL, SAYBOLT
A scale used for measuring the viscosity of oil, expressed in seconds required for a specified amount of oil to flow through an orifice; hence the larger the number of seconds, Saybolt Universal (SSU), the more viscous the oil.

UPPER LIMIT OF INFLAMMABILITY
The maximum percentage of fuel in an air-fuel mixture which can be ignited. Above this percentage, the mixture is too rich.

USBM
United States Bureau of Mines. Also referred to as BuMines.

USDI
United States Department of Interior.

UTILITY BOILERS
Those boilers used by utility companies to raise steam for power generation. Usually a boiler in excess of 100 MW or ~1,000,000 pounds of steam per hour rating, and of high pressure ($\geq$2000 psi) and temperature ($\geq$ 1000°F). Contrast with industrial boilers.

VALVE CONTROL
A system for control of air/fuel ratio by mechanical linkage of valves having the same characteristic.

VAPORIZING OIL BURNER
A burner in which the oil is vaporized in a single step by direct heating of the liquid.

VELOCITY PRESSURE
The difference between total pressure and static pressure; that is, the difference between the pressure which a fluid flowing in a pipe exerts upon the upstream face of an obstruction in the pipe and the pressure which it exerts upon the walls of the pipe.

VENT
A small hole or opening for the escape of a fluid. Also, to release fluid.

VENTURI
A section in a pipe or passageway that converges to a narrow constriction, then smoothly flares out again. Named for the Italian physicist G.B. Venturi (1762-1822), who first noted the effect of constriction.

VIBRATING GRATE
A type of stoker made up of a grate structure (water-cooled tubes) supported on equally spaced vertical plates that are free to move back and forth in a rectilinear direction. The grate is inclined and periodic vibration conveys the coal from a hopper through the furnace.

VISCOSITY
The tendency of a fluid to resist flow.

VISCOSITY, ABSOLUTE
The product of a fluid's kinematic viscosity times its density. Absolute viscosity is a measure of a fluid's tendence to resist flow, without regard to its density. Sometimes the term dynamic viscosity is used in place of absolute viscosity.

VISCOSITY, KINEMATIC
The relative tendency of fluids to resist flow, including the effect of the fluid's density.

VOLATILES
Properly, volatile matter. Those products, exclusive of moisture, given off by a material as gas and vapor under the specified conditions or process.

VOLUME, COMBUSTION
The space occupied by the fuel while it is actually burning, including both the flame and invisible combustion zone.

VOLUME FLOW RATE
The quantity (measured in units of volume) of a fluid flowing per unit of time, as cubic feet per minute or gallons per hour.

VOL. % or % V
Volume Percent

VOLUME, SPECIFIC
The volume occupied by one pound of a substance under any specified conditions of temperature and pressure.

VOLUMETRIC ANALYSIS
A statement of the various components of a substance (usually applied to gases only), expressed in percentages by volume.

WALL LOSS
The heat loss from a furnace or tank to or through its walls.

WARMUP TIME
The time required to bring a furnace and its charge, if any, up to operating temperature. The same as bring-up time.

WATER COLUMN
A unit used in measuring pressure. One inch of water column equals a pressure of 0.578 ounces per sq in.

WATER (BLUE)GAS
An artificial fuel made by forcing steam over incandescent carbon to form a mixture of hydrogen and carbon monoxide. ($C+H_2O \rightarrow CO+H_2$.) The gas is poisonous because of its high CO content.

WATER GAS SHIFT REACTION
A further reaction of the water gas (which see) to give H_2. ($CO + H_2O \rightleftarrows H_2 + CO_2 + \Delta H$.)

WATER GAUGE
Visible gauge tube showing water level in boiler; or sight glass. Also see water column.

WATER TUBE BOILER
A boiler in which the hot gases are in contact with the outside surface of the tubes, and the boiler water and steam are in contact with the inside surface of the tubes.

WATER WALL
A water cooled surface (wall) surrounding the combustion zone; may be a tube wall or a channel wall.

WEATHERING
Slow oxidation of coal in storage.

WEIGHT FLOW RATE
The quantity (measured in units of weight) of a fluid flowing per unit of time, as pounds per second.

WEIGHT, SPECIFIC
The weight per unit volume of a substance. The same as density.

Wt. %, or % W
Weight percent.

WET BOTTOM
A boiler unit in which the ash is melted or slagged and tapped or removed as a fluid from or near the bottom of the furnace.

WET ANALYSIS
Analysis by qualitative or quantitative chemical methods as opposed to instrumental monitoring.

WET SLAG
Molten or liquid slag of sufficient fluidity to "wet" a surface and flow as a liquid.

WIND BOX
An air plenum chamber, usually under the grate or grid of the combustion space.

ZERO GAS
Gas at atmospheric pressure (zero gauge pressure).

ZERO GOVERNOR: See atmospheric (ratio) regulator.

ZONE, CONTROL
That section of a furnace within which temperature is controlled by the throttling action of a single valve.

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